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Art. XV.—*Notes on some "Stringybark" Eucalypts.*

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(With Plates X and XI).

[Read 11th July, 1912].

I.—The Occurrence of Eucalyptus Consideniana *(Yertchuk)* in the Lower Yarra District.

For some years past one of us has had under observation near Eltham a single "stringybark" tree which was evidently not *E. macrorhyncha*, nor any of the other common species known to be present in that district.

About eighteen months ago another specimen was found near Lilydale, presenting considerable differences both in the size and shape of its carpels and even, as we have since found, in the oil distilled from its foliage.

We have since proved that they are both forms of *E. Consideniana*, the "Yertchuk" discovered by A. W. Howitt[1] in Gippsland, and described by J. H. Maiden,[2] but this is the first record of its appearance so near Melbourne, and our verdict as to its identity has been confirmed by Mr. Maiden. The tree itself grows on the poor soil overlying the silurian shales and resembles the stringybarks of the district (*E. macrorhyncha*) in general appearance and height. The bark, however, is softer and less furrowed, and the leaves are narrower; in these respects it resembles the messmate (*E. obliqua*), but this does not occur near Eltham. The carpels also usually differ from those of *E. macrorhyncha* and other allied species in possessing a red rim and in not being domed.

The usual difficulty of discriminating between the various "stringybarks" was accentuated by the considerable variations shown, especially by the carpels. (See Plate X.)

These variations, which will be referred to later, are much greater than are indicated by Maiden, and it seems advisable to amplify his description.

In our endeavour to identify the tree and to decide whether the various forms observed were of one species only, we sought further information in three directions.

1. Trans. Roy. Soc. Vic., ii., p. 82.
2. Crit. Rev., vol. i., p. 312, and Proc. Linn. Soc. N.S.W., 1904, p. 475.

We examined (1) the seedlings, (2) the flowers, and (3) the chemical composition of the oil.

(1) *The seedlings.*—Many seeds of both the Eltham and Lilydale forms and, for comparison, seeds of about half-a-dozen more or less similar species, were planted in small pots.

The resulting seedlings conclusively eliminated *E. pilularis* and *E. eugenioides.*[1]

Seedlings of *E. macrorhyncha*, *E. Muelleriana* and *E. obliqua* appear indistinguishable in a photograph, although a closer examination show minor but definite differences in each case. Carefully selected typical specimens of the seedlings examined are illustrated in Plate XI.

(2) *The flowers.*—Although buds had been visible for several years, no flowers were observed until the beginning of this year, when both trees came into bloom, and the inflorescence was seen to be identical.

The trees were covered with an abundance of prominent panicles of bloom, white in colour and honey-scented.

The buds in the early stages are narrow and pointed like those of *E. macrorhyncha*, but before flowering they become more swollen and then more nearly resemble the Eastern form of *E. Consideniana* described by Maiden.

Considerable searching in the district of the lower Yarra, especially between Greensborough and Lilydale, has resulted in the discovery of about a score of trees, several of which have been most prolific in bloom.

It is certain that the species was much more common in past years throughout this district, and that the present scarcity is due to its selection by timber splitters, who look upon it as a superior kind of messmate. Indeed, several of the trees that we have had under observation have been cut down during the last few months and utilised in this way. The wood is a clean splitting and durable fencing timber, and resembles that of the yellow stringybark (*E. Muelleriana*), in appearance.

(3) *Chemical composition of the oil.*—This species may possibly be the "peppermint" from which the first eucalyptus oil was distilled by Surgeon Considen (one of the founders of Australia), after whom the tree has been named by Maiden. In any case it is closely related to *E. piperita*, the species generally supposed to have that honour. In view of this possibility, it is fitting that a chemical examination of its oil should be carried out and placed on record.

The oil obtained from the leaves by steam distillation is perhaps not an infallible criterion, but the work of Baker and Smith and,

1 With regard to the latter we would point out that there appear to be two distinct varieties which may possibly both be worthy of specific rank. The form compared here is the ordinary variety occurring so plentifully in Gippsland.

incidentally, our own experiments on these stringybarks have shown that each species yields its own characteristic oil, which varies less than any of the other features usually relied on by morphologists for the identification of botanical species.

We shall therefore describe in some detail our experiments on the oil.

Foliage was collected from four different trees, and in each case one or more sacks of the leaves were distilled with steam in an experimental still at the University Agricultural Chemistry Laboratory. The 400-gallon tanks usually employed in the commercial extraction of eucalyptus oils hold about half a ton of leaves. Our still had a capacity of some twenty pounds only, but the processes were the same in principle in both cases, except that we were able to carry out our operations quantitatively.

The distillation was generally considered to be complete after three and a-half hours. In one experiment the following measurements were noted: —

Time of distillation (hours)	1	2	3	4
Oil distilled	49 cc. ...	18 cc. ...	9 cc. ...	1 cc.

Eucalyptus oils, in general, are mixtures of pinene, phellandrene and eucalyptol, liquids boiling at 156 deg., 172 deg. and 176 deg. respectively. They may contain also small percentages of less volatile complex aldehydes and a sesquiterpene (aromadendrene), with traces of more volatile alcohols, aldehydes and esters.

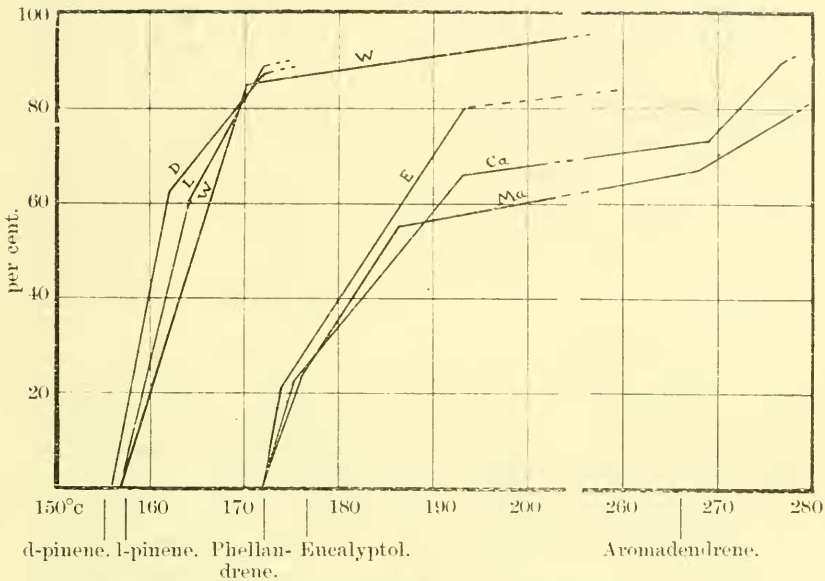
The physical properties of an oil will naturally depend on the variety and proportions of the ingredients present, and are often, though not always, a useful guide to its composition.

A careful fractional distillation enables us, partially, at least, to separate the different constituents and form an approximate estimate of the amount of each present. It should also be a preliminary to the quantitative determination of eucalyptol, aldehydes, etc.

We have for this purpose used a glass still of definite dimensions sealed on to a rod and disc fractionating column so that a definite degree of fractionation will always be obtained. If the quantity of distillate passing over between definite temperature limits be plotted in the form of a temperature-percentage curve, we have a very convenient method of graphically comparing different oils.

In dealing with an unknown oil, refractionation is resorted to, and derivatives of each component prepared, and identified by their physical constants.

Fig. 1.



D. = *E. dextropinea* (d = ·877, α = + 38°). E. = *E. eugenioides* (d = ·913, α = +4°)
L. = *E. laevopinea* (d = ·875, α = − 47°). Ca. = *E. capitellata* (d = ·917, α = + 4°)
W. = *E. Wilkinsoniana* (d = ·894, α = − 24°). Ma. = *E. macrorhyncha* (d = ·929, α = − 1°)

In Fig. 1, the curves are given for several of the typical stringybark oils, and, although the data recorded by Baker and Smith are somewhat scanty for this purpose, the difference between each curve is clearly to be seen, and corresponds to the characteristic composition of each oil.

These curves distinguish two classes of stringybarks, the one including such species as *E. laevo-pinea*, etc., which yield oils commencing to distil at about 156 deg. C, and containing either dextro - or laevo - pinene, and the second, which like *E. macrorhyncha* yields oils containing phellandrene, but not pinene, and only beginning to distil at above 170 deg. C.

Whereas some of the constituents can be directly determined by chemical methods, others such as pinene can only be approximately estimated by a more or less reliable calculation from the physical constants of the oil and its fractions.

The method we adopted is as follows:—

Fifty cubic centimetres of the oil are fractionally distilled in duplicate, and the density, optical rotation and refractive index of each fraction is observed. The lightest fraction is analysed for volatile aldehydes by absorption with a sodium bisulphite solution; eucalyptol

is determined by the resorcin method in the middle fractions boiling from 170 deg. to 190 deg., and the highest fractions are utilised for the estimation by hydroxylamine of aromadendral and associated aldehydes. The optical rotation of the middle fractions gives a measure of the phellandrene content of the oil, when a qualitative test has shown it to be present.

Baker and Smith[1] discovered that if the leaves of *E. macrorhyncha* be extracted with boiling water, a considerable amount of a yellow dye, which they isolated and named myrticolorin, was obtained. This is an important character in the comparison of the stringybarks, and we have readily confirmed their observation, but find little or none of the dye to be present in the leaves of either *E. Consideniana* or of *E. Muelleriana.*

Five different distillations of oil, from four trees of widely varying ages, were examined, and the results are given in Tables I. and II. Nos. I., II. and III. are from trees growing within a quarter of a mile of one another between Eltham and Greensborough. No. IV. was taken from a tree on similar country between Lilydale and Evelyn.

The differences in percentage yield are very marked, but are in accord with the variations in this respect observed in several species.

The optical rotation, however, also shows considerable fluctuations from tree to tree: the chemical significance of this variable rotation is not quite clear, owing to the impossibility of accurately determining the amount of phellandrene present. It has been suggested that the optical rotatory power of *l*-phellandrene is not a constant.

Chemical tests showed that the oil consisted mainly of phellandrene and aromadendrene with about ten per cent. of eucalyptol and small amounts of aromadendral.

TABLE I.

Physical Constants of Oils from the Leaves of *Eucalyptus Consideniana.*

	Approx. Age of tree.	Date of distillation.	Percentage yield.	Volumes 80 per cent. alcohol dissolving one volume oil.	Specific gravity.	Optical rotation.	Refractive index.
Ia.	20-30 years	July, 1911	0.55	insoluble	.876	−44.0°	1.4795
Ib.	,, ,,	Oct., ,,	0.50	insoluble	.871	−49.4°	1.4790
II.	70-100 years	Sept., ,,	0.65	1 vol.	.885	−36.5°	1.4790
III.	100-150 years	Oct., ,,	1.05	2 vols.	.896	−23.5°	1.4837
IV.	50-70 years	July, ,,	0.20	1¼ vols.	.905	−17.3°	1.4804

TABLE II.

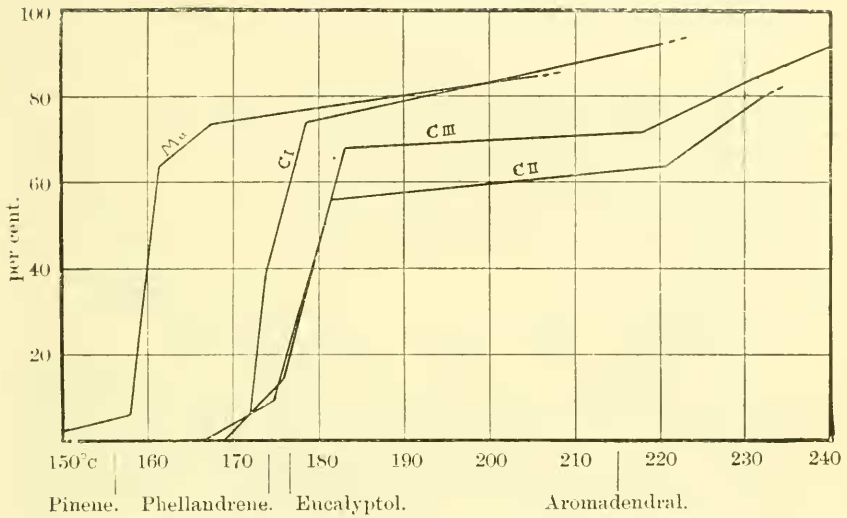
Chemical Properties of Oils from the Leaves of *Eucalyptus Consideniana.*

	Eucalyptol.	Alcohol.	Volatile aldehydes.	Higher aldehydes.	Esters.
Ia.	8.7 9.6	.88 .83	1.7	1.4	2.7
Ib.				—	1.2
II.	2.51 2.50	2.6 2.1	2.3	—	4.5
III.	7.5	—	0.5	—	1.6

We were unable to detect pinene or endesmol in any sample.

1. Smith, Journ. Chem. Soc. (1898), **73**, 697.

Fig. II.



Mu = *E. Muelleriana*: C I., C II., C III. = *E. Consideniana*.

The distillation curves obtained for three of the oils examined are given in Fig. II., and will be seen to fall between those of the two classes of stringybark oils shown in Fig. I. There is undoubtedly a wide variation here, as well as in the optical rotation, partially, though not quite, bridging the gap between this species and others closely related.

It will be of interest to compare this variation of chemical characteristics with that shown by the carpels so largely used by morphologists as a basis for the classification of the eucalypts.

Of the carpels figured in Plate X., No. I. was forwarded to one of us by Mr. J. H. Maiden, as a type of the species occurring near Metung, Gippsland; it can be almost exactly matched by a carpel of *E. Sieberiana:* Nos. 2 – 9 were all collected from one single tree, that growing at Eltham, and from which oils Ia. and Ib. were distilled, and they also have been matched by carpels from eight different species as indicated. No. 10 grew on a Lilydale tree and the divergence exhibited in the chemical composition of the oil is seen to be more pronounced in the shape and size of the carpel, which closely resembles that of E. *macrorhyncha.*

Such a wide variation as we have found is not indicated in J. H. Maiden's description of the species, nor in the accurate and detailed field notes of Dr. Howitt, where he pictures the Yertchuk as he saw it in Gippsland. It may be noted that the latter describes the timber

as being worthless for splitting; possibly the value put on the tree by woodmen around Eltham may be due to the dryness of the soil in that district.

Conclusion.

The composition of the oils and their physical constants, as tabulated, are not matched by the oil of any of those species examined by Baker and Smith that could possibly be regarded as similar to the Yertchuk. Hence from morphological characters of the buds, carpels, leaves, seedlings and bark, as well as from the characteristic oil distilled from the foliage, it is evident that these trees in the valley of the lower Yarra can only be included in the species *E. Consideniana;* for although they show considerable variations among themselves, they diverge still further from any other known species.

Mr. J. H. Maiden has included a very careful review of this species in his Critical Revision of the Eucalypts (Vol. I., p. 312), with accurate figures of the forms found in New South Wales, but for the reasons given we would venture to amend and amplify his description of the species, indicating our own alterations and additions by means of italics.

Description.

A tree of medium height, *varying from 20 to 60 feet.*

Bark.—Fibrous, resembling *Eucalyptus obliqua*, but softer, grey in colour on the outside, and *reddish inside* (*inner bark yellowish, like E. Muelleriana.*). Persisting up the trunk and main branches. *Small branches smooth; branchlets angular.*

Juvenile Leaves.—*Seedlings: Leaves opposite*, narrow-lanceolate, *soon becoming ovate and ovate-lanceolate to broad ovate-lanceolate, and acuminate; smooth or rough*, sessile and petiolate, varying from one inch to three inches in length, and one half-inch and more in breadth, *grey-green or sap-green in colour. Margins entire or undulate with small tufts of stellate hairs, stems reddish, warty glandular, ultimately smooth.*

Epicormic Shoots.—*Leaves opposite, shortly petiolate, obtuse, ovate to broad ovate-acuminate, slightly oblique and falcate, and lanceolar-acuminate, often nearly straight, becoming alternate with longer petioles.*

Branchlets smooth, terete and angular. Intramarginal vein distinct, not far removed from the margin, with a second faint vein between the inner and outer margins.

Primary and sub-primary veins spreading and distinct.

Mature Leaves.—Alternate, petiolate, narrow to broad *lanceolate, straight or falcate, oblique and acuminate, firm in texture, with a hardened recurved point.*

Varying in length from 2 to 9 inches, and from $\frac{1}{2}$ to $2\frac{1}{2}$ inches in width; *erect, horizontal or drooping.* Colour equally green on both sides, dull or shiny, blue-green or a bright sap-green.

Veins strongly marked, and spreading; intramarginal vein, often looped, and *not far removed from the edge.*

Oil-dots numerous.

Buds.—*Numerous or few*, clavate, with *or without* pointed opercula. (*Some Southern forms are more "macrorhyncha"-like in the young state than the Eastern would appear to be*).

The pointed opercula less conspicuous when matured; young buds are provided with calyptra-like bracts.

Flowers.—*Inflorescence paniculated or axillary; panicles sometimes leafless. Stamens: White, uniform in length. Anthers reniform.*

Flowers honey scented.

Fruits.—*Very variable in size and shape; (three forms sometimes occurring in one umbel); pedunculate, pedicellate, or sessile, pedicels varying from 1 line to half-inch in length.* Pyriform, *pillular*, conical or *hemispherical.*

Rim usually reddish, smooth, broad, flat or slightly domed.

Valves, *one to five* sunken; the small deltoid points sometimes slightly exserted. *Umbels, solitary or paniculated, containing from 1 to 8 fruits, $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter.*

Peduncles, slightly angular or flattened. Calyx tube tapering or suddenly contracted into the pedicel.

Timber.—Wood, pale-coloured, with kino rings, remarkably like that of the common Sydney Peppermint (*E. piperita*) or of the "Yellow Stringybark" (*E. Muelleriana*). *A durable timber, in demand for fencing, when growing in dry country.*

Oil from leaves.—*Specific gravity, 0.87 to 0.91; optical rotation —15° to—50°; refractive index, 1.479 to 1.480. It is usually,*

though not always, soluble in one or more volumes of 80 per cent. alcohol. It consists essentially of phellandrene with some aromadendrene and from 2.5 to 10 per cent. of eucalyptol.

The leaves contain little or no myrticolorin.

II.—The Oil of Yellow "Stringybark" (*Eucalyptus Muelleriana*).

As it had been suggested that the Yertchuk trees described in the preceding section were forms of the yellow stringybark, it seemed desirable to make a direct comparison of their oils.

The oil of *E. Muelleriana* has not been described by Baker and Smith, nor does this species grow nearer to Melbourne than Southern Gippsland; but, by the courtesy of Mr. H. Mackay, Conservator of Forests, who has had a supply of the foliage collected for us at Yarram, we have been enabled to distil and examine the oil from the leaves of two trees, one mature and the other a sapling.

The oils from these two trees were almost identical except for an insignificant difference in colour (a brilliant greenish blue), although the yield from the mature foliage was twice as great as from the sapling.

This identity is a striking confirmation of the reliability of the composition of the oil as a specific characteristic.

The table of physical properties of these two samples and of other oils obtained from the ordinary or red stringybark (*E. macrorhyncha*),[1] still further illustrates this consistency.

TABLE III.

Physical Constants of Stringybark Oils.

	Locality.	Date.	Percentage yield.	Solubility in alcohol.	Specific gravity.	Optical rotation.	Refractive index.
E. Muelleriana—							
Sapling	Yarram	Nov., 1911	0.40	insoluble in 80 p.c.	0.887	+20°	1.4735
Mature	„	„	0.80		0.884	+22°	1.4738
E. macrorhyncha—							
Mature	Eltham	Oct., 1911	0.11		0.923	6.5°	
„	„	Feb., 1912	0.11		0.914	±0	1.4923
„	N.S.W.	*	0.27	soluble in 1¾ vols. 70%	0.929	±0°	1.4802

* Average results given by Baker and Smith.

1. In the case of *E. macrorhyncha* oils, the small yields obtained have rendered impossible their systematic chemical examination and fractional distillation, but their physical constants may be compared with the results given by Baker and Smith (Research on the Eucalypts, p. 147) for trees grown in New South Wales.

Photograph shewing variation of fruits of Eucalyptus Consideniana, and comparison with other species.